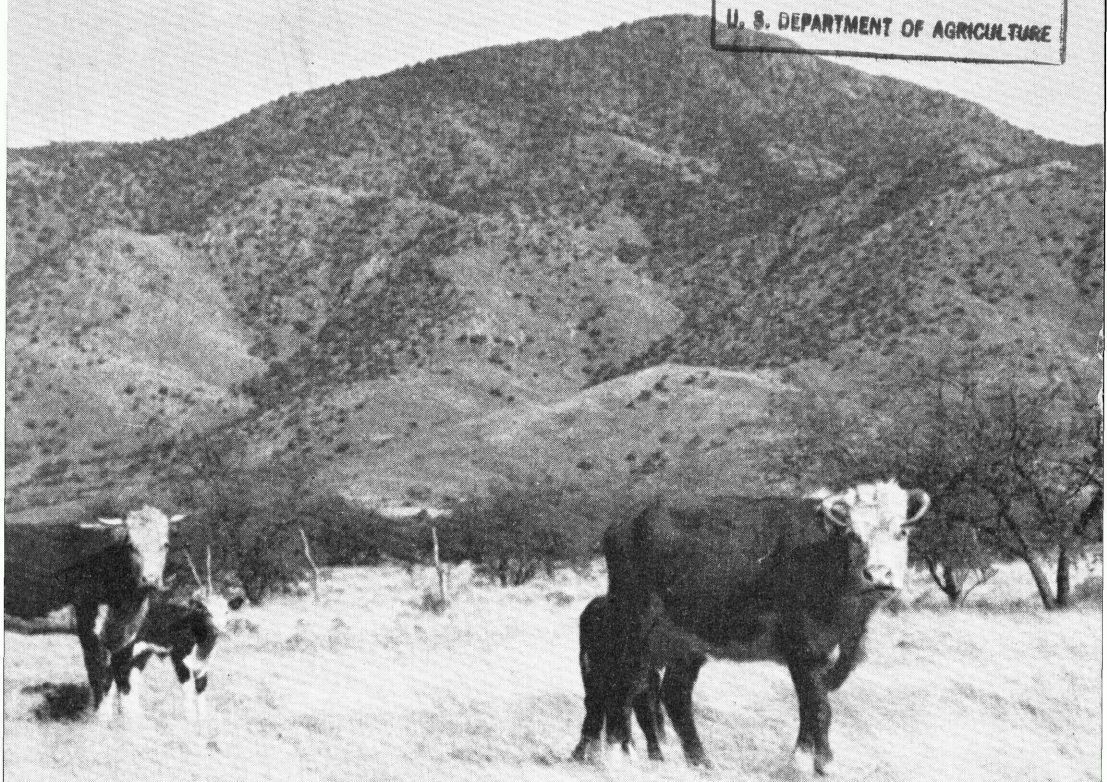
INDICATORS
of Southwestern Range Conditions



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IN THE SOUTHWEST, sustained production of low-cost range forage is a vital factor in profitable livestock raising. Every stockman needs to know when he has grazed his range to a degree that will still insure an equal or greater production of forage in the years to follow. Accurate judging of range condition—being able to determine from present evidence whether the range is actually improving, or whether it is "going downhill"—is essential. As far as possible, actual facts must be the basis of judging. The purpose of this bulletin is to point out indicators of range conditions, their significance, how to detect deterioration in its early stages, and other indicators of proper and improper range use.

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INDICATORS OF SOUTHWESTERN RANGE CONDITIONS[1]

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CONTENTS

THE NECESSITY AND DIFFICULTY OF RANGE EVALUATION

THE STORY of range use and misuse, dating back many years, is written on the range itself. Sometimes this record is clear and unmistakable; but more often it is framed in characters—like the clay tablets of the ancients—dimly uncertain and in code. Fragments of the key to this code have been found; but some are misleading, and a few are still missing. Until the pattern is more nearly complete, decipherment of the indicators will continue to be difficult. And yet, range judging must go on as an inescapable process in the use of grazing resources by a big industry.

This range resource in the Southwest is of vital economic importance. Available grazing lands in Arizona and New Mexico total over 135 million acres—nearly 90 percent of the total land area of these States. Moreover, these lands are not merely forage factories. Many of them have other important values, including watershed protection, timber, wildlife, and recreation.

The problem is further complicated, directly or indirectly, by natural land features. Grazing grounds are found at elevations of from 1,000 to 13,000 feet. Relief varies from nearly flat plains and mesas to steep rocky mountains (figs. 1, 2, 3). Character of ground surface,

[1] Revision of a handbook entitled "How To Judge Southwestern Range Conditions," issued in 1924 by F. C. W. Pooler, regional forester, to forest officers of the Southwestern Region. Through incorporation of more recent findings, the material has now been brought up to date jointly with the assistance of the Southwestern National Forest Region and the Southwestern Forest and Range Experiment Station. Acknowledgment is especially due D. A. Shoemaker and W. G. Koogler of the region, and C. K. Cooperrider and B. A. Hendricks of the station.

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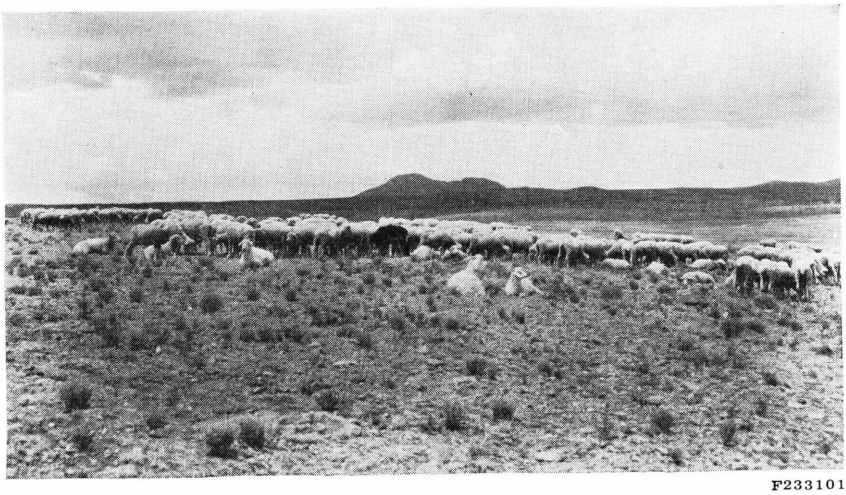

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FIGURE 1.—A level or undulating short-grass range. Other things being equal, a satisfactory ground cover of high grazing capacity can be maintained more easily on such an area than where topography is less favorable.

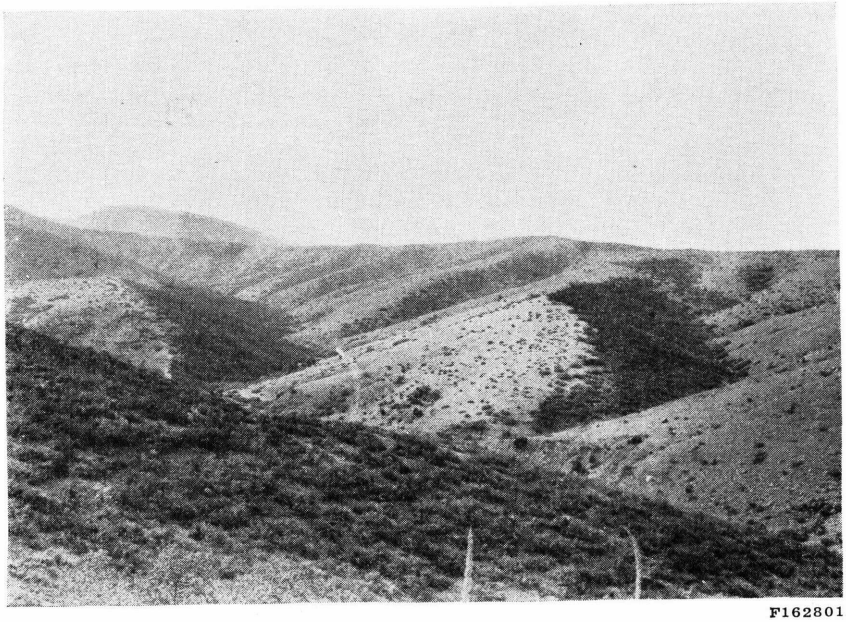

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FIGURE 2.—Rolling range. When slopes are steeper, runoff waters attain higher velocities and have far greater erosive power; hence, in order to maintain satisfactory range condition, somewhat lighter grazing is necessary than on more level areas.

soil, type of vegetation, aspect, degree of slope, and climate—all affect forage production and use. Areas of high elevation cannot be grazed more than 3 months; many at lower elevations are used throughout the year. There is tremendous variation in seasonal distribution of precipitation as well as in the annual amount, which seems to rise and fall in irregular cycles of years; while periodic droughts make difficult the evaluation of other factors that tend to cause decline in forage production.

Many more simple, usable measures of the principal forage types and plants than are available are needed. Further study is imperative. Although much progress has been made in recent years, yet with the growing interest in range management and the interwoven public

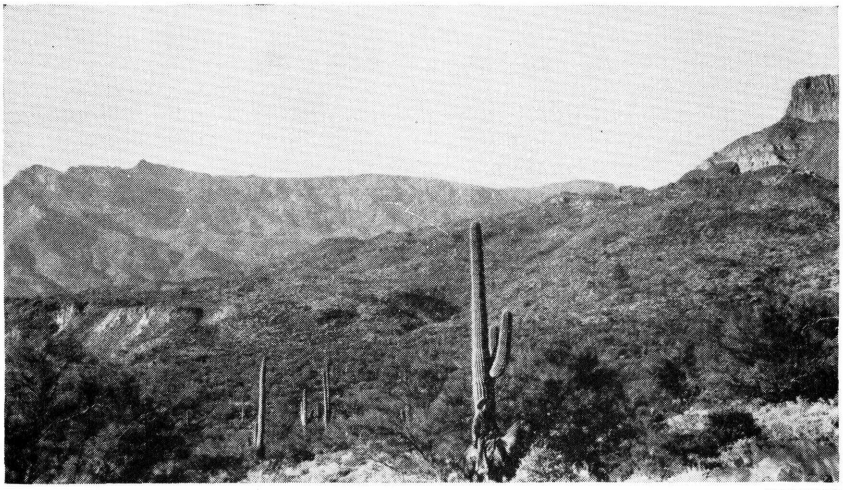

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FIGURE 3.—Rough, rugged grazing grounds. From the standpoint of topography alone, land of the character shown in the background must be grazed least of all if a satisfactory cover of vegetation is to be maintained.

values inherent in range lands, greater uniformity in judging—in finding out the meaning of the "signs on the ground"—is essential. After improvement—or decline—has reached an advanced stage, the condition is usually unmistakable and the importance of indicators is correspondingly less. The range manager must be able to detect the first stages of very gradual processes which may be trending toward range improvement or range decline.

Of especial importance, therefore, in adequate management of southwestern grazing lands, are usable criteria of range condition—the various less obvious things taken into account consciously or intuitively by experienced examiners—along with the basic principles of range judging. It is with these indicators that this bulletin is concerned.

WHAT RANGE INDICATORS ARE AND WHAT THEY INDICATE

Range indicators are the clues to range happenings. All that can be used as guides to recognition of the real state of affairs—nonuse,

satisfactory use, abuse—either in the past or present, may be classed as indicators. For the most part these are telltale details of the kind and condition of range plants, and the behavior of the soil mantle of the range. Such indicators are thus related not only to the forage and its condition, but also to such things as soil, topography, and climate.

In any consideration of indicators, it is well to keep in mind that they are nothing more than indicators. As indicator is only one witness; testimony from all possible witnesses should be considered before a verdict is rendered. So considered, they possess high practical value as aids in understanding and applying the results of actual range practice and experiment in improving range management. In the following pages are outlined, in the light of present knowledge, examples of the practical use of southwestern indicators. These examples pertain primarily to Arizona and New Mexico, but the underlying principles are believed to be applicable wherever similar range types occur.

When the word "indicator" is used in connection with range judging, it too often has been the practice to think at once of "indicator of overgrazing." This term is both erroneous and unfair unless restricted closely to its intended meaning. Range deterioration is not always started by grazing abuse. A number of other factors, operating in varying degree, have disturbed nature's original balance. Each factor has its own weight. All combine to produce the final result. Overgrazing is admittedly one of the most important causes of range damage—in many instances it is the largest factor—but it is not the only one, and it is not alone responsible for all of the injury to ranges and watersheds.

SIGNS OF A DETERIORATING RANGE

Weakened Vitality of Principal Forage Plants

The cumulative effect of excessive grazing (or any detrimental influence) is first evidenced by such things as pale, unnatural (sickly) color of herbage, reduced height of growth, and reduced volume of crop. These symptoms appearing over extensive areas might be called the first danger signals and usually precede more pronounced signs. There are two checks to the examiner's judgment as to what is sickly color or reduced height of growth: (1) His own experience and knowledge of what a vigorous crop of the particular forage type should look like; and (2) comparison with similar nearby conservatively grazed or ungrazed areas. In considering height, it is well to remember that owing to unfavorable site conditions, height growth of forage plants in general is often much reduced at the frontiers of their zones of occurrence. Marked seasonal reductions in height growth are also caused by severe drought.

Close Grazing of Inferior Forage Species

In the matter of appetite, grazing animals are much like people—given a choice between "hardtack" and fried chicken, they eat the chicken. Palatability means more than nutritive content. Various bunchgrasses, such as Arizona fescue (*Festuca arizonica*) are "hardtack," and commonly are not utilized to a noticeable extent until the

more palatable plants have been eaten closely. Therefore, in mixed types when "hardtack" is found closely eaten, the better-liked plants usually have been injured.

Another example of this is sacahuista or "beargrass" (*Nolina microcarpa*). During recent droughts this plant was heavily grazed in places in the Southwest. Ordinarily it is but lightly grazed and—with the exception of new shoots, buds, and blossoms—is usually ignored by stock. When the animals are forced to graze it closely, it is safe to assume that other more palatable forage plants have been seriously damaged (fig. 4).

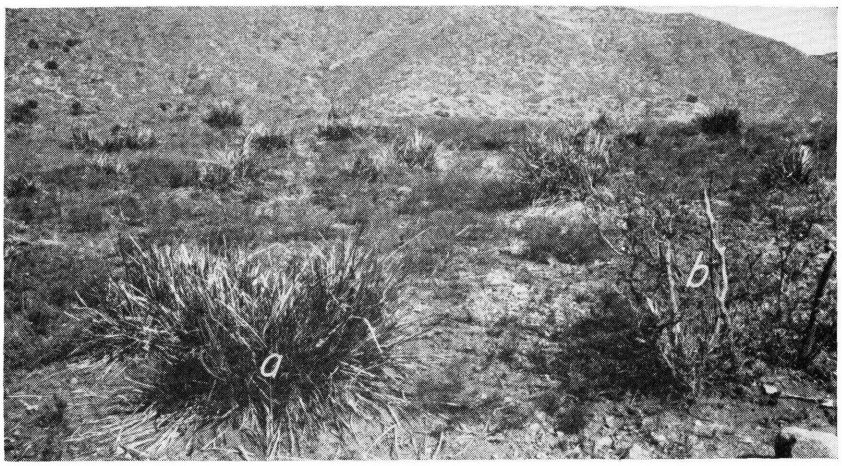

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FIGURE 4.—Seriously overgrazed range at 5,000 feet elevation. Sacahuista ("beargrass") (*a*) is heavily browsed. Bushes of catclaw (*Acacia greggi*) (*b*) are almost dead. The original stand of hairy grama (*Bouteloua hirsuta*) and curlymesquite grass (*Hilaria belangeri*) has been thinned and in its place broom snakeweed (*Gutierrezia sarothrae*) is coming in.

The contrary, however, is not true; the fact that inferior or worthless plants are untouched is by no means an assurance of no overgrazing. Here other indicators must be consulted as well (fig. 5).

Thinning Ground Cover of Vegetation

Thinning grass cover, as a result of overgrazing, shows up first in an accelerated dying out of disintegrating tufts. This condition can easily be distinguished even by the inexperienced examiner from the natural occurrence of dead grass intermixed with green that may be found at times on ungrazed areas.

On ranges where palatable shrubs form an important part of the forage, continued close browsing at first tends to thicken the individual bushes. Later the cover thins out alarmingly. When the danger point in intensity of use is crossed, the damage to the vegetation shows up in three generally recognizable conditions:

1. Twigs eaten back farther than 1 year's growth, the bushes resembling trimmed hedge plants (fig. 6).

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FIGURE 5.—Nonpalatable or inferior plants may be undependable indexes. The inferior and sometimes poisonous sleepygrass (*Stipa robusta*) was untouched by livestock on this overgrazed area.

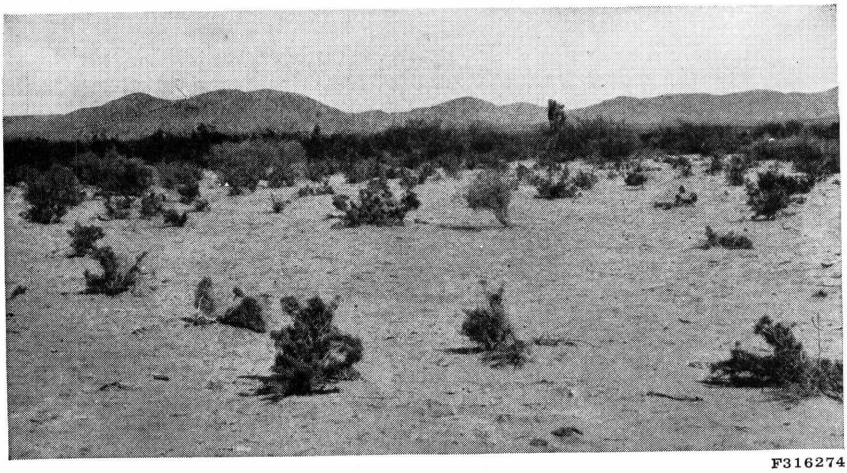

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FIGURE 6.—Stubby, closely trimmed shrubs on grass-browse range usually constitute a reliable index of overgrazing. In general, shrubs are more grazing-resistant than grasses. The damage to saltbush (*Atriplex*) shown in this picture indicates that the original stand of grama has doubtless been seriously reduced and gives the cue for other checks of that condition.

2. Numerous dead branches and occasional dead bushes.
3. Absence of good browse reproduction.

Here the grass stand already will have been seriously reduced.

Replacement of Good Forage Plants With Poor Ones

Replacement of good forage plants with poor ones always means lessened production of valuable forage (fig. 7). An example would be a range on which "sixweeks grasses," weeds, or inferior shrubs are actually encroaching upon areas originally dominated by blue

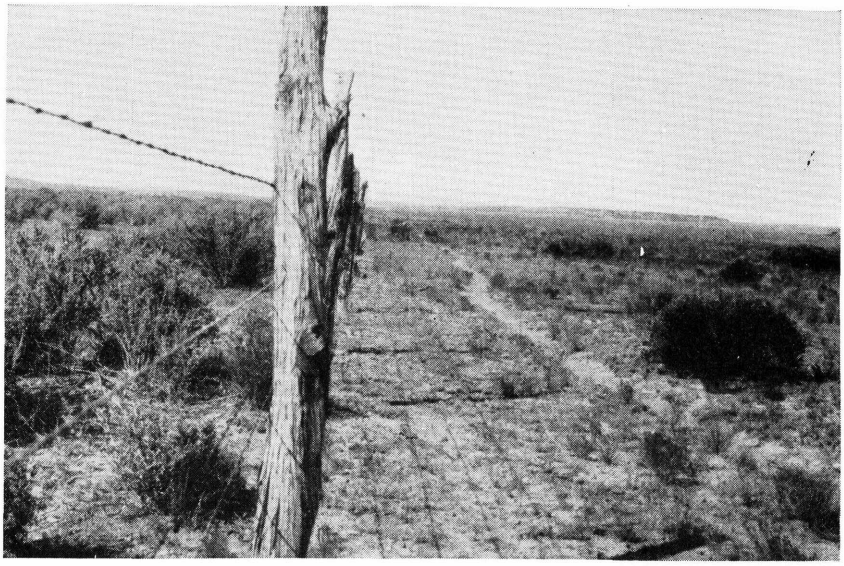

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FIGURE 7.—The replacement of good forage plants as an indicator. Deterioration of the right-hand range is clearly indicated by: (1) The abundance of palatable fourwing saltbush (*Atriplex canescens*) in the managed range to the left and its absence on the range to the right; (2) invasion of inferior rabbitbrush (large dark plants) and snakeweed (smaller plants in between), along with a thinning of grama sod. The main cause of the change in type is overgrazing. Contributing causes are more obscure but include drought.

grama. The difficulty is to recognize actual encroachment at the present time, as distinct from existing remnants of past encroachment which may be found on ranges that are now improving. To aid in a correct reading of these signs, one may well remember (1) that an abundance of young inferior plants (especially current year's seedlings) as compared to mature plants, coupled with other signs of range deterioration, such as a lack of vigor or actual thinning of good forage plants, indicates invasion actually occurring; and (2) that a vigorous stand of the good forage species, and a relative scarcity or absence of young plants of inferior quality, indicate that any earlier invasion of undesirable weeds has been halted.

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Accelerating Erosion

The use of erosion as a grazing indicator is full of chances for error. Any attempt to correlate present erosion with present grazing is especially difficult. Two generalizations will be found helpful: (1) Distinct increase in number of recent gullies certainly indicates a "slipping range," and is frequently but not invariably one of the later stages of overgrazing; (2) failure of vegetation to reclaim very small gullies resulting from past abuse also is a hint that recuperation has not yet begun. (See also p. 14.)

Faulty Indicators

Local denudation.—Small denuded areas supporting little or no herbaceous vegetation may not indicate range abuse but rather a heavy soil content of gypsum or other salts unfavorable to plant growth (fig. 8).

Poisonous plants.—In general, livestock losses from poisonous plants are greatest during periods of forage scarcity (fig. 9); but experimental data are not yet available to warrant a definite statement regarding the detailed relationship of overgrazing to poison-plant abundance, species by species.

Condition of animals.—Poor condition of livestock, often associated with ranges on the decline, has distinct limitations as an indicator of heaviness of grazing, because of the influence of various other factors, including the history of the season's use and condition of the animals when entering the area. At best, condition of livestock is a

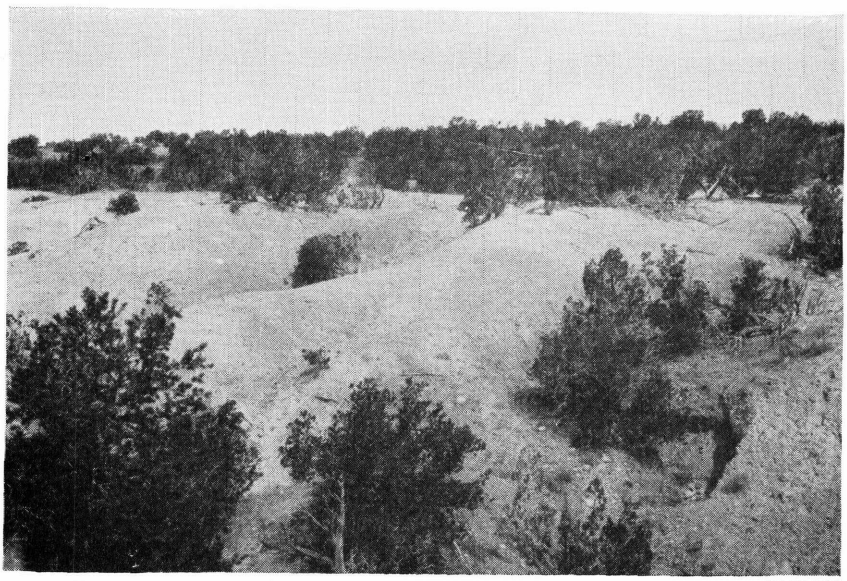

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FIGURE 8.—Absence of forage is not always due to overgrazing. In places in the Southwest the soil contains high concentrations of mineral salts that are detrimental to the growth of most forage plants. Grazing is a very minor factor here.

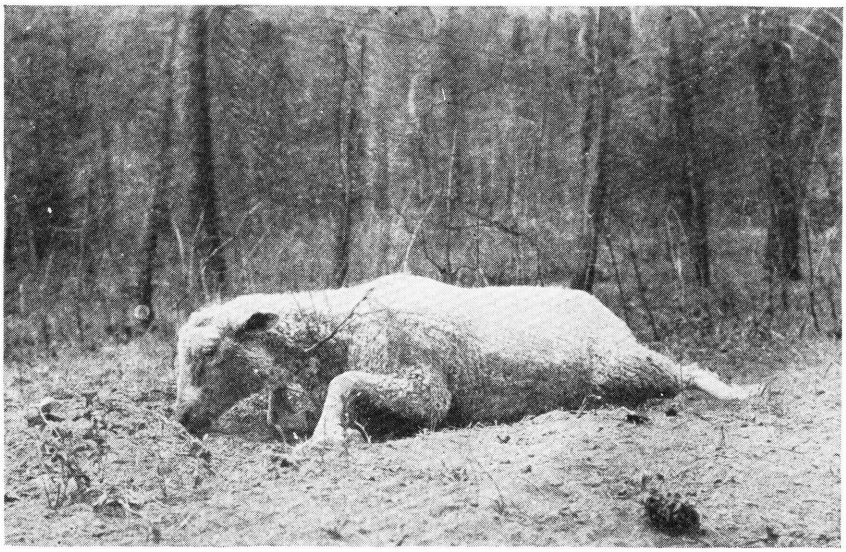

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FIGURE 9.—Feed shortage increases the danger of losses from poisonous plants.

tricky factor. During favorable forage years, for example, livestock may do reasonably well, for a time, at the expense of the range.

Condition of timber reproduction.[3]—The effect of grazing on timber must be given careful consideration in all inspections of forested ranges. Highlights of the findings in studies made by the Southwestern National Forest Region and the Southwestern Forest and Range Experiment Station follow:

Ponderosa pine.—Serious damage has occurred on overgrazed areas, resulting in a temporary dwarfing (fig. 10) and, in extreme cases, in the death of pine reproduction; but some damage is also found on ranges properly used from a forage standpoint. Consequently, browsing damage to reproduction is not a reliable indicator of a deteriorating range. Palatability, succulence, and sufficiency of forage and season of use and availability of water for livestock are important considerations. Much less damage is found on areas where forage is ample and largely composed of succulent grasses and herbs than on areas where the drier, coarse bunchgrasses predominate. Damage is less on well-watered areas and greatest during the dry late spring and early summer.

Spruce and fir.—Serious local injury to reproduction on overgrazed areas. Studies similar to those in regard to southwestern ponderosa pine are needed to establish final conclusions for the various phases of the problem.

Aspen.—Severe damage to aspen sprouts is largely restricted to overgrazed localities, to places where animals congregate or where aspen makes up only a small part of the total forage.

[3] Small trees between seedling and sapling stages.

Juniper and piñon.—Negligible damage is done to seedlings of these trees by domestic livestock in Arizona and New Mexico except in overgrazed localities.

Three cautions: (1) Absence of satisfactory reproduction is not a reliable index of overgrazing; other possible causes, or at least contributing factors, include fire, rodents, inadequate number of seed trees, and unfavorable site conditions. (2) Insects, particularly the tip moth, often cause a distorted stunted appearance of ponderosa pine seedlings, very similar to grazing damage. Care should be taken to distinguish between these two types of injury. (3) It is not always possible to distinguish livestock browsing of timber reproduction from browsing by game animals, which in areas of heavy game populations may assume serious proportions when forage scarcity is acute (fig. 11).

EARMARKS OF PAST RANGE DAMAGE

Disappearance of Formerly Abundant Forage Plants

This earmark is tricky, for in order to draw correct conclusions one must know what the particular type of country is capable of growing. Moreover, it refers to a condition which, to anyone not familiar

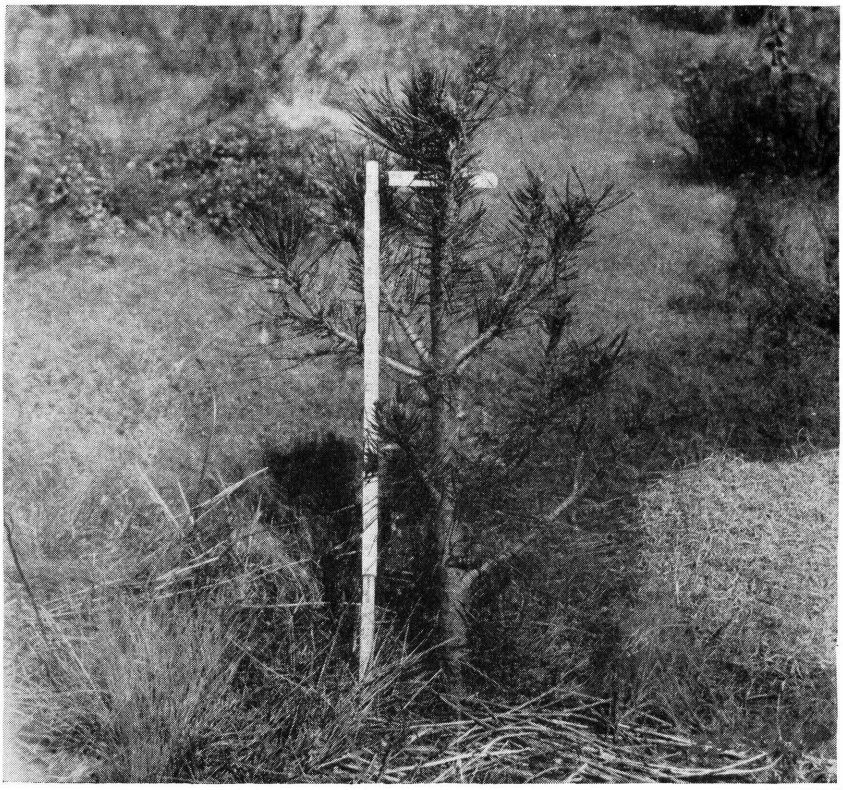

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FIGURE 10.—Young ponderosa pine with stunted, distorted branches showing the result of past damage done by browsing livestock.

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FIGURE 11.—A "deer line" on trees reflects damage from game animals. On this overpopulated game area, leaves and twigs of juniper and piñon trees have been browsed to a conspicuous and fairly uniform level—as high as the animals could reach. Low shrubs have been more seriously damaged.

with the specific type of range, might not be recognized as overgrazing. There are examples of such areas having been reported as excess-forage areas. For instance, there exist plant associations in which certain very palatable plants formerly comprised 20 to 40 percent of the forage, the remainder being made up of less liked and less valuable bunchgrasses. Through continued heavy grazing, the very palatable plants were either killed or kept so closely nipped as to be hardly noticeable, whereas the low-value bunchgrasses were not eaten to any marked degree. To a casual observer, the unused bunchgrass would indicate surplus range. But if such overgrazing is not detected and controlled, it will in time result in the practical disappearance of the less abundant but nevertheless very important species of higher palatability. Aids to the recognition of this condition include: (1) Occurrence of surviving bunches of palatable grass on small hummocks, the lower, surrounding soil being either bare or covered with inferior plants; (2) statements of reliable pioneers, or other records, relative to the former vegetation; (3) comparison with local areas ungrazed or conservatively grazed for a number of years.

On pine bunchgrass it is dangerous to attempt to justify local killing out of native bunchgrasses by the assumption or hope that "something better will come in." True, such replacement has occurred in certain high-mountain areas, mostly above 8,000 feet in elevation, in which conditions are very favorable, where Kentucky bluegrass (*Poa pratensis*) has spread and is still spreading in drainage lines and over slopes formerly mantled with less palatable bunchgrasses. In these exceptional and localized cases an introduced species has often proved to be more desirable than the native species from the standpoint of forage values.

It should be remembered, however, that the killing out of admittedly less palatable plants, such as Arizona fescue, is usually followed by growth of still less desirable plants. Where the hope is voiced that grama or other semisod grasses may replace bunchgrasses, it must

also be remembered that the former spread slowly on mountain areas where bunchgrasses are the normal cover. On the Coconino Plateau, in Arizona, forage cover weakened by overgrazing continued to improve after 10 years' protection from grazing. *There is no greater fallacy prevalent in the range country than the impression that "one good seed year will bring back an overgrazed range."*

Abnormal Abundance of Indicator Plants

Most of the native plants in the following lists originally were found in small quantities on ranges that have remained in good condition; nevertheless, their presence in abundance (often locally dominating the stand) on any range is sufficient cause for suspecting bad handling in the past. Some of the more common of these so-called plant indicators of disturbance are:

Snakeweed, rabbitbrush (*Chrysothamnus*), groundsel (or butterweed) (*Senecio*), tumbling Russianthistle (*Salsola kali tenuifolia*), pricklepoppy (*Argemone*), burroweed (*Aplopappus fruticosus*), and pinguë (*Actinea richardsoni*).

Inferior perennial grasses, including threeawns (*Aristida* spp.), burrograss (*Scleropogon brevifolius*), fluffgrass (*Triodia pulchella*), and ring muhly (*Muhlenbergia torreyi*).

Inferior annual grasses, including mat grama (*Bouteloua simplex*), sixweeks dropseed (*Sporobolus microspermus*), and false buffalograss (*Munroa squarrosa*).

Annual grasses and weeds may occur locally in great abundance and still not indicate any abnormal condition. For example, over many desert ranges in southern Arizona the rainfall is inadequate in amount and distribution to maintain a good stand of perennial grasses through the many weeks of high summer temperatures. Here, a heavy growth of "sixweeks forage" perhaps has always followed favorable winter rains and may develop after favorable summer rains.

The need for knowing the vegetation is thus emphasized by the introduction, locally, of foreign plants. Russianthistle is an example of an aggressive introduced weed of limited forage value. Many introduced plants are weed pests; others are valuable forage plants, for example, Kentucky bluegrass and alfileria (*Erodium cicutarium*), commonly called "filaree."

Accelerated Soil Erosion

Widespread, serious erosion, when not explained by some condition beyond man's control, reflects land mistreatment in the past.

However, it should be remembered that there are two broad classes of erosion. *Normal erosion*, continuous through the ages, occasionally and locally has been very rapid, but in general is a very slow process with which soil development keeps pace. Normal erosion should be recognized as nothing to be alarmed about; all agricultural lands have been made by it. Opposed to it, however, is the *accelerated erosion* which has been increasing in many parts of the Southwest for many years and which in most cases is directly the result of man's occupation of the country. In appraising range conditions, the presence or absence of this destructive type of erosion (figs. 12 and 13) is considered an invaluable yardstick in judging proper range use,

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FIGURE 12.—Unmistakable earmarks of a deteriorating range. It is clear that permanent damage will result on these grass-depleted, eroding slopes unless the causes of deterioration are quickly removed.

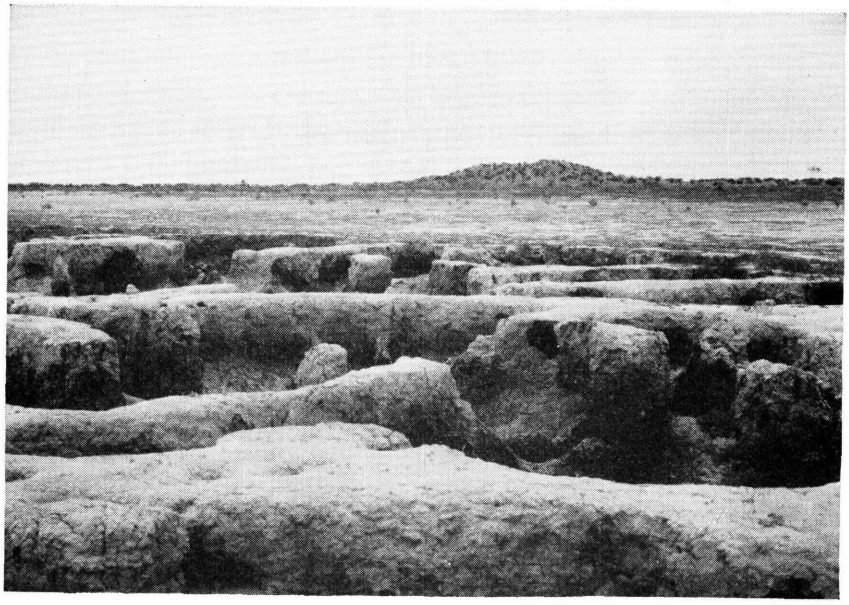

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FIGURE 13.—Range destruction recognized by everyone.

since protection of watersheds is one of the prime objects of land management and since the washing away of the fertile topsoil reduces productivity now and for the future—considerations that affect both the public and private landowner.

INDICATIONS OF SATISFACTORY USE

Satisfactory utilization of the different classes of range is very difficult to describe, particularly in those classes composed of mixtures of many species. Experienced range examiners find it much easier to point out actual areas (fig. 14) on which utilization is regarded as

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FIGURE 14.—A bunchgrass, mixed-grass-weed range in satisfactory midseason condition. Plenty of forage remains to insure a small surplus at the end of the season. Valuable perennial forage plants predominate. The density of vegetation is about as great as the climate and soil of the region will support.

satisfactory than to put on paper any set of guides for other men to follow. Nevertheless, attention to a few points will be found helpful.

In general, a satisfactory condition of range is indicated by: (1) Vigorous appearance and stand of forage (fig. 15); (2) absence of accelerated soil washing; (3) lack of extensive areas overrun by unpalatable plants; (4) slight or no use of unpalatable species; and (5) on timber-producing areas, absence of serious injury to timber reproduction. Excellent evidence that a previously depleted range is improving includes: (1) Thickening of the stand of good forage; and (2) the reclaiming of gullies by vegetation (fig. 16).

Experience and experiments have shown that some forage should remain ungrazed at the end of the season to provide a little leeway for the drier years and to maintain the forage vigor. Specific evidences of healthy conditions for three broad classes of range—short-grass, bunchgrass, and browse—follow.

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FIGURE 15.—Semidesert grassland in bloom. This thick stand, thrifty condition of forage, and excellent soil protection are the results of deferring grazing in this pasture each year until the forage plants had fully matured, followed by conservative use.

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FIGURE 16.—A definite sign of a range "on the mend." Following the establishment of proper grazing, grasses have reappeared in this gully and have started to heal it.

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Short-Grass Plains and Mesas

1. An average of at least 40 percent, on a volume basis, of the available crop of palatable herbage and 25 percent of the flower stalks left unused at the end of the grazing season.
2. Palatable plants in vigorous condition, as shown by color, general appearance, and height growth. Very good density; absence of dead tufts of thinning sod. Absence of young growth of unpalatable plants.
3. Gullies, or arroyos, stabilized by vegetation.
4. Absence of formation of new gullies.
5. Absence of noticeable sheet erosion.

Mountain Bunchgrass Ranges

1. Height of grazed-off tufts. In contrast to various short grasses, such as several gramas, most bunchgrasses are dependent upon seed for reproduction and therefore cannot safely withstand such close and continuous use. An example is Arizona fescue, which cannot safely be grazed below 6 inches in height, and fragmentary evidence indicates that cropping as close as this, if repeated year after year, will be injurious. Careful observations indicate that species of ranker growth, such as Thurber fescue (*Festuca thurberi*), should have a still higher stubble left after grazing. In any event, animals do not crop bunchgrasses to a uniform height, as a mowing machine would. Then, too, some grass tufts or bunches are preferred to others, and often only a portion of each bunch is chewed off to any given height. Consequently, height alone is an insufficient criterion.

2. Percentage of ungrazed flower stalks. On ranges on which livestock run throughout the entire growing period of the plants, at least 25 percent of the flower stalks should be permitted to mature. Utilization of palatable weeds and of small grass tufts will generally be much greater than that of larger tufts. From 50 to 60 percent of the current year's volume growth of the more palatable species (junegrass, bluegrasses, bromegrasses, sedge, etc.) and from 45 to 75 percent of the other bunchgrass species, depending upon the palatability of each, should be left on the ground. On an average this would mean about 50 percent[4] of the current year's growth. These guides should promote greater uniformity in range judging. There is, of course, the difficulty of determining "25 percent of the flower stalks" or "50 percent of the current year's growth," and here again, comparable ungrazed or protected plots will be found very useful. These percentage guides, for tufts and flower stalks, directly pertain to only one factor: vegetation vigor. The other considerations, topography, exposure, soil, erosion, timber, etc., apply to bunchgrass range as they do to other range.

In judging whether use of a bunchgrass range is satisfactory, it is a good plan to consider the possibility of maintaining forage vigor by "resting" portions of the range in turn, through some form of deferred and rotation grazing.

[4] This figure applies only to "fairly pure" bunchgrass ranges, where bunchgrasses predominate. The percentage will vary as forage composition varies, and may run as high as 80 percent (for the low-value bunchgrasses) on areas where other forage plants predominate.

Browse Ranges in Deserts and Foothills

Recognition of satisfactory conditions on these brushy ranges involves some additional points:

1. Moderate use of palatable shrubs—palatable brush not grazed down to stubby branches. About 25 to 40 percent of the current year's growth of the better and widely distributed shrubs within reach of livestock should be left ungrazed at the end of the grazing period.
2. Light use of inferior browse species.
3. Unpalatable brush practically ungrazed.
4. At least 40 to 50 percent, depending upon species, of the available crop of perennial grass herbage left unused.
5. On desert ranges, a portion of the crop of annual weeds and grasses left for soil protection at the end of the grazing period.
6. Presence of young plants of valuable browse species.

There are certain areas on which the growth of brush is so dense and vigorous that it cannot be grazed down and prevented from growing out of reach of animals without inviting serious erosion. On such ranges conditions should be judged by the utilization of the grass and presence or absence of erosion of the soil rather than by the condition of the brush. This also applies to ranges such as that shown in figure 2, where dense brush occurs on northern and grass on southern exposures. Attempts to graze the browse heavily under such conditions are apt to cause damage to the stand of grass, the principal erosion-control agent both in the shrub stand and in the grassland areas.

WHAT IS EXCESS FORAGE?

Excess forage is that part of the ungrazed forage on a range which under practicable handling can still be utilized without range damage. Unused forage is merely uneaten forage, which may or may not be eaten later to advantage. Clearly, then, excess forage always means some usable ungrazed forage, but unused forage may not be excess. It is most important to keep this distinction clear.

Secondary plants of lesser palatability, such as tobosa (*Hilaria mutica*) and various bunchgrasses, occurring in small percentages within a main type of grama which is better relished by livestock, are not indicators of unused forage. In such small amounts or on the less used slopes (fig. 17) such secondary plants will probably not be grazed and would not be utilized to a material degree before the more palatable species were grazed to the ground. *In such cases, the unused patches of vegetation should not be considered excess* (fig. 18).

In a bunchgrass range in ponderosa pine country, unused portions of bunchgrass which experience of the region has shown cannot be grazed more closely without unwarranted injury to young pine growth is not excess forage. Areas of bunchgrass now very lightly grazed which can be safely utilized by better but altogether feasible control of livestock are excess, and therefore to be considered as unused forage.

On all ranges the recommended safety margin of ungrazed herbage is not excess.

On brush ranges, shrubs which seem to be "gaining on livestock" and bid fair ultimately to "take the range" are not excess forage if the intensity of grazing necessary to hold them in check and down within

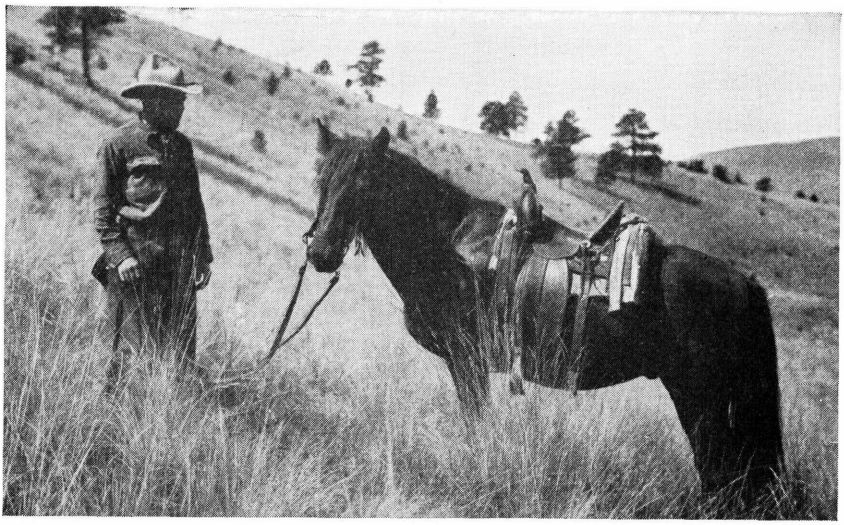

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FIGURE 17.—Is this excess forage? No, unless the grazing animals could be herded on this bunchgrass slope. This photograph was taken on a northern exposure on a cattle range where the better liked grama grasses on all southern slopes were fully utilized.

F165887

FIGURE 18.—Utilization of many forage species varies with their abundance. The season was well advanced when this photograph was taken, and a stocking heavy enough to force cattle to eat the small islands of ungrazed tobosa (*a*) would have seriously damaged the black grama (*b*), which was already closely grazed. Wherever tobosa grass predominates, however, it is an important forage plant, if used in summer.

the reach of grazing animals entails the decided thinning or wiping out of more palatable grasses or other forage plants (fig. 19), or an increase in soil washing. This is usually just what happens, although it is not apt to be well recognized, if the attempt is made to graze steep, brushy slopes (fig. 20) heavily enough to keep browse plants from growing beyond the reach of grazing animals.

On desert ranges, the big waves of annuals or "sixweeks plants" may be considered excess if the extra livestock moved in to utilize the temporary forage can be moved out as the green forage begins to wane. Locally, such flexibility in the handling of livestock is feasible

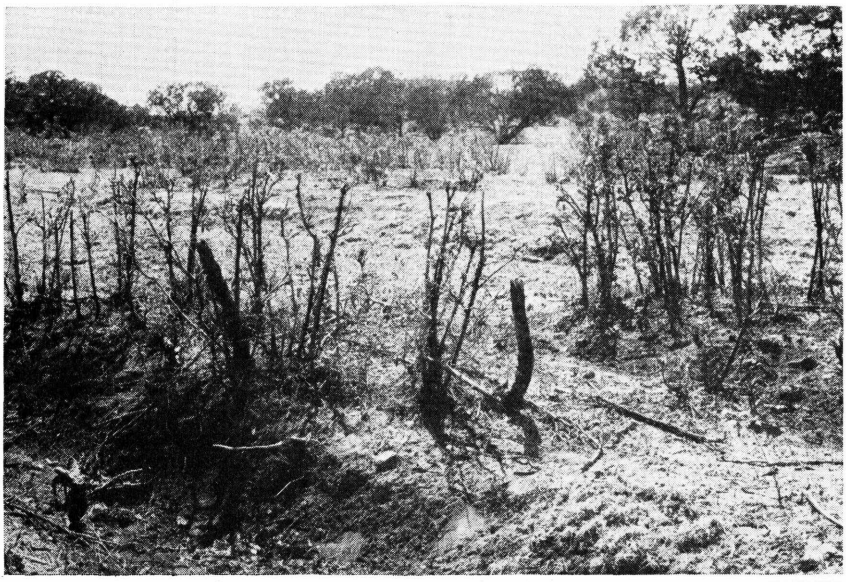

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FIGURE 19.—Unmistakable overgrazing indicators. These are (1) increasing erosion—roots of bushes and grasses party exposed; (2) thinning of grama sod; (3) intensive browsing of oak bushes to the point of stubby appearance, or even the killing of occasional plants.

with sheep, but with cattle it is rare. Unless it is certain that the herds can be moved when this uncertain irregular crop begins to dry up, it is not excess forage (figs. 21, 22).

In judging excess forage it is necessary to know what portion of the year constitutes the grazing period. Without this knowledge, areas unused in autumn but reserved for winter grazing might, in September, erroneously be regarded as excess.

Fire menace alone should not determine excess forage. The beneficial effect of grazing in reducing fire risk should be fully appreciated, but if grazing sufficiently close to eliminate most of the fire risk means decided damage to important portions of the range, the unused portions should not be considered excess.

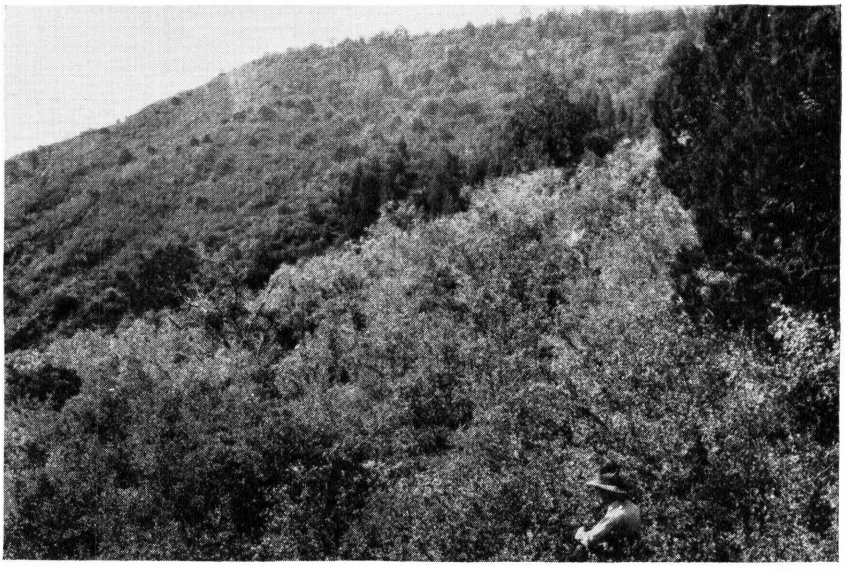

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FIGURE 20.—A very dense mixed-browse range. The brush in this locality is rapidly growing beyond the reach of grazing animals; yet grazing sufficiently heavy to insure stunting the bushes and opening up the stand is rarely justified on watersheds of this steepness because of the danger of serious soil washing.

F171435

FIGURE 21.—Very heavy growth of "sixweeks forage." This shows occasional conditions on desert ranges in early spring. Livestock can be accommodated for short periods on such areas provided the animals can be promptly removed when these short-lived crops dry up and disappear.

SIMPLIFIED USAGE OF COMMON GRAZING TERMS

Much uncertainty during inspections and lack of understanding of reports can be avoided through closer adherence to clear and uniform meanings of a few everyday range terms. On national-forest ranges, the following distinctions in definition have been found especially helpful:

An area is overgrazed when consequential damage, due to grazing, has occurred to plants or soil—or to both (figs. 23, 24, 25, 26). Overstocking prevails when the number of animals on any specific area cannot be maintained through the intended grazing period without resultant damage.

It is evident that the time element must be clearly stated in applying these definitions. For example, an area may have been overgrazed

F162795

FIGURE 22.—The scarcity of "sixweeks forage" during a dry year. This photograph, taken at a different time in the same locality, shows the scarcity of this kind of forage during drought years, and also during dry periods of every year. This illustrates the fallacy of placing dependence upon these temporary and uncertain forage crops in most years.

in the past but be lightly stocked at the time of examination. Another area may be overstocked but not yet overgrazed. For example, if forage sufficient for only 100 cattle is produced on an area and 150 are placed on it with the intention of leaving them throughout the grazing season, the area is overstocked, although no damage to either range or livestock may be apparent for several months. The above definitions should be closely adhered to because of no little confusion in the past through the use of these terms interchangeably.

The following definitions are not so rigid and represent more nearly the average usage of inspectors: Where less than 10 percent of the forage on an area is eaten at the end of the grazing period, the area may be classed as practically unused. The term "moderately grazed" is usually applied when about 50 percent of the palatable herbage on

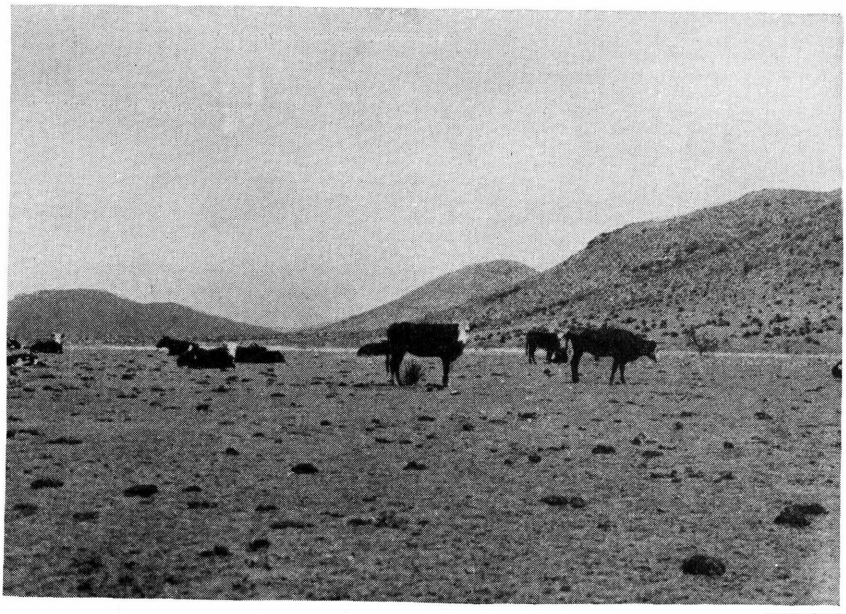

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FIGURE 23.—A destructively overgrazed range. Where too many animals have congregated for years, there is (1) a general thinning of the sod; (2) disappearance of valuable forage plants; and (3) an increase of erosion.

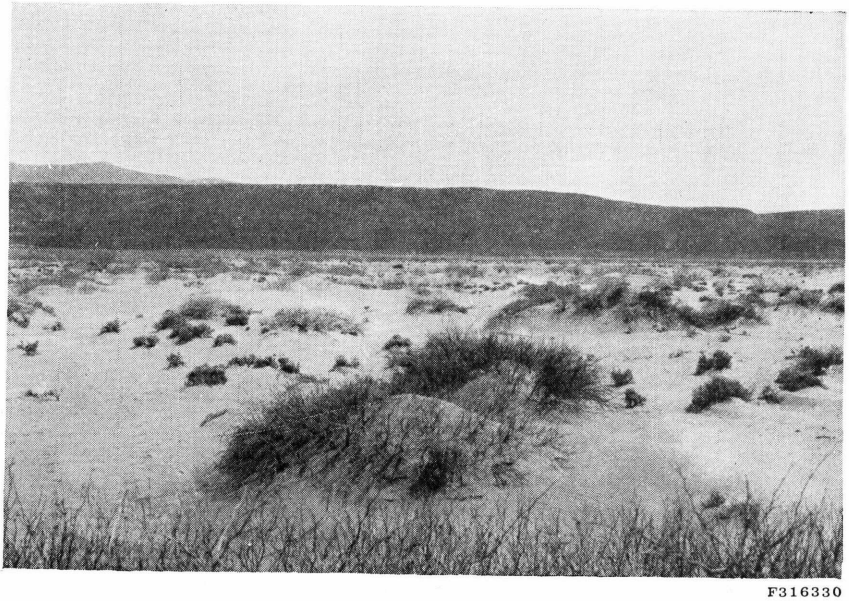

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FIGURE 24.—Approaching the last stage of range deterioration on sandy soil. When the original covering of perennial vegetation is weakened sufficiently to allow soil blowing, the remaining forage plants are damaged or destroyed by drifting sand.

F171978

FIGURE 25.—A damaged area in the high summer ranges. Unmistakable earmarks of overgrazing are: (1) Grazing down to dead stubs and even the killing of willows; (2) disappearance of easily killed-out valuable forage plants, leaving the more resistant bunchgrasses on hummocks; (3) thinning of vegetation and the beginning of bad erosion.

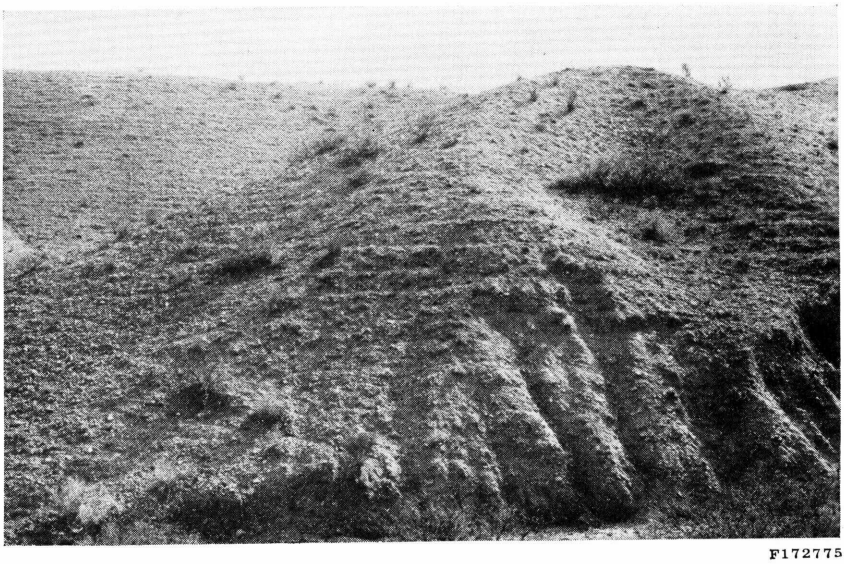

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FIGURE 26.—An example of destructive overgrazing on steep slopes. Note the network of contour stock trails and cross-cutting gullies.

short-grass range and about 25 percent on bunchgrass range is taken during the grazing period (p. 14 for further discussion of satisfactory use). The phrase "dangerously grazed" is applied to any degree of utilization that, in the judgment of the inspector, is likely to result in damage.

These few terms can be employed as indicated to convey fairly uniform meanings. However, the meaning of such terms as "close," "fairly close," "very close," and "exceedingly close" (as applied to forage utilization) is vague; their usage should be discouraged, except when supplemented with percentages. Incidentally, the employment of percentages to express forage utilization is very good practice. The evident advantages of this method are (1) more definite statements—although still brief, (2) clearer pictures of conditions, and (3) a record of the meaning of terms in current use by the particular examiner.

What is grazing capacity? It has been variously defined as follows: The number of animal units that the range will support under present methods of management—what it will carry and still maintain maximum forage production—what stocking it will bear and leave a small margin for slow improvement—what it will carry without much risk of a "die-off." But these definitions are contradictory and the need is for a common meaning which all can clearly understand. When this term is used by the Forest Service on national-forest range the meaning is that well defined in Department Bulletin 790, Range Management on the National Forests. This is one that holds good for any range unit: "The maximum number of stock which the unit will support each season over a period of years without injury to the range, tree growth, or watershed, or unwarranted interference with game and recreation."

For indicators of unsatisfactory conditions brought about by any cause, the use of the general term "disturbance indicators" is suggested, to avoid confusion with the term "overgrazing indicators" which has the more restricted meaning.

WHY RANGES DETERIORATE

Range deterioration may be either rapid or slow; it may be due to past or present misuse; it may be preventable or unavoidable. In the Southwest it usually is traceable to a combination of several causes, all of which should be taken into account in judging the range.

Overgrazing.—Overgrazing may have been occasioned by: (1) Too many animals for the available forage; (2) grazing too early in the spring (fig. 27); or (3) poor distribution of livestock, resulting in heavy concentrations in open accessible parks near water (fig. 28) and light use of outlying areas.

Drought.—Recurrent drought leaves its mark directly on the range in a serious reduction in density and volume of important forage plants. Drought also weakens many plants, which will, however, survive if not grazed too closely. When overgrazing is permitted during drought, an even more serious reduction in forage values occurs. Such overgrazing is apt to occur if livestock numbers are not reduced to meet the lowered forage production during drought or if a conservative basis of stocking is not maintained through the years.

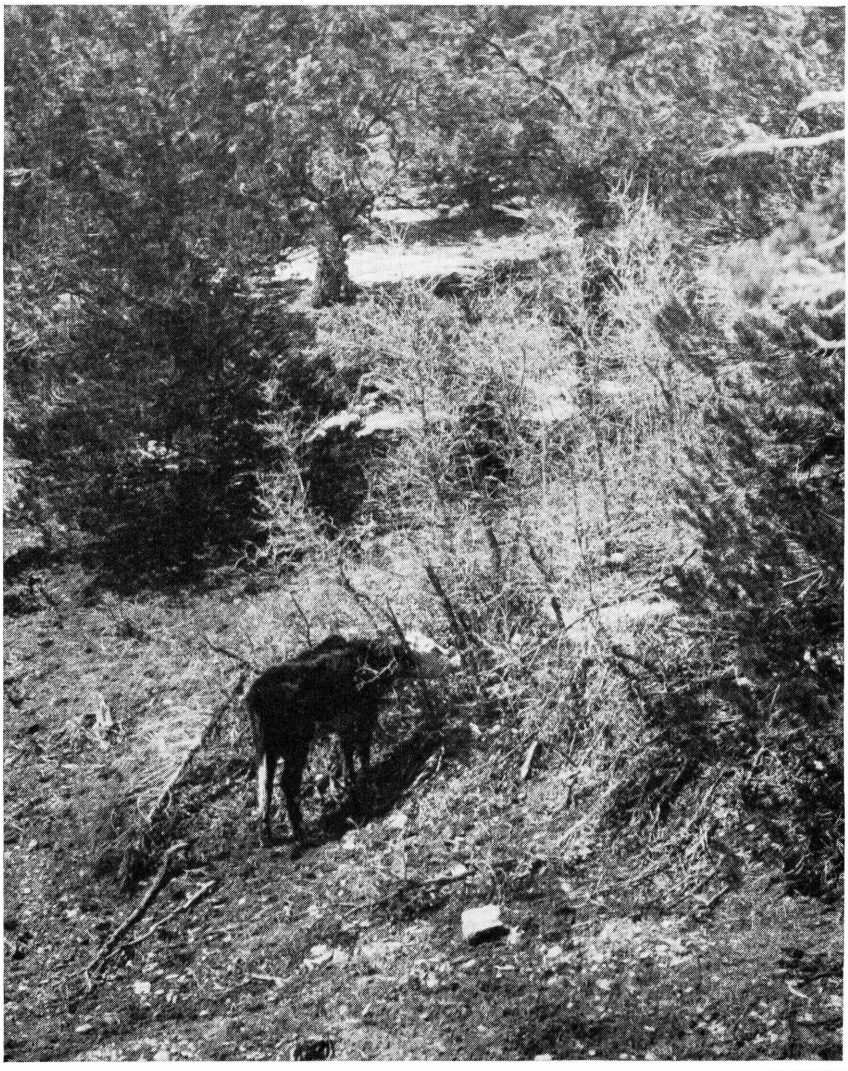

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FIGURE 27.—Too-early grazing of a mountain range. If grazing animals are allowed to follow the receding snows too closely, when the new forage growth is still scant and the steep slopes are soft and muddy, both the range and the animals suffer.

Roads and trails.—The construction of roads and trails has been primarily responsible for much destructive washing of soil. In the early days throughout the range country, many sod-bound valleys and canyon bottoms were traveled by wagon and by pack trains. Some of these travel routes were later abandoned; others are still traveled. In either event vegetation cover has been broken (fig. 29),

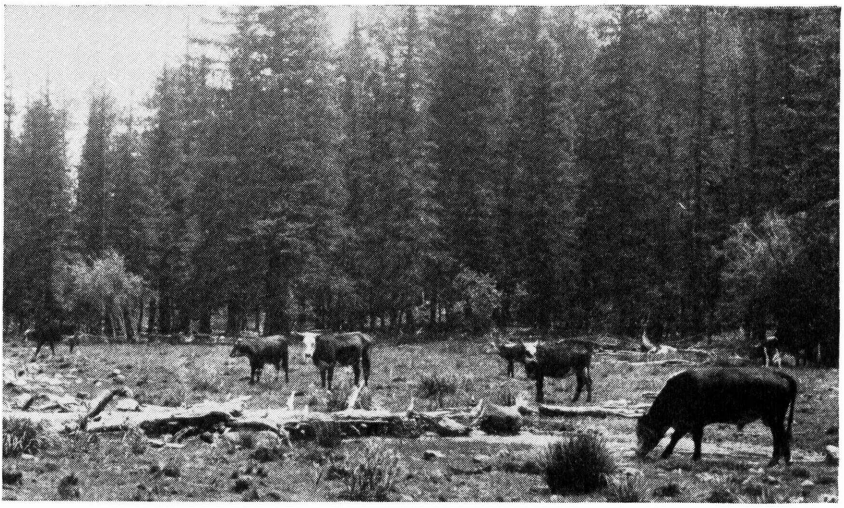

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FIGURE 28.—One cause of past overgrazing of mountain meadows. Open parks and mountain meadows, especially those near water, are apt to be more heavily grazed by either sheep or cattle than the rest of the range. Close supervision and progressive handling are needed to safeguard these valuable sources of summer forage.

F159688

FIGURE 29.—A disturbance indicator. Rabbitbrush is here shown conforming closely to the narrow strip where travel has weakened the former vegetation.

and soil washing has been invited (fig. 30). Modern road grades, with their heavy cuts and fills, and their drainage systems, designed to keep the water off the highway grade, have been the direct cause of much soil erosion.

Cultivation.—The plowing of the original forage sod in many valleys and swales, and occasionally on slopes of dangerous steepness, has been a powerful agent in starting erosion which has continued far beyond the confines of the area originally cultivated. Forage production has also been reduced, especially in fields cultivated for a time and then abandoned (fig. 31).

Range-destroying rodents.—Prairie dogs in particular strip bare the range about their burrows and, where they are abundant, may

F162772

FIGURE 30.—Gullies follow the wagon wheel. Roads have been the direct cause of the beginning of destructive erosion in many drainage lines. Gully cutting has been invited, even on many modern roads, by inadequate road drainage and the concentration of floodwaters in culverts.

cause damage over large areas (fig. 32). Various other rodents such as kangaroo rats, mice, and gophers, have caused range injury variable in character and intensity, but the exact role of each species remains to be determined.

Fire and logging.—Destructive fires temporarily remove most of the vegetation barrier to soil washing which may follow, locally, especially if heavy rains fall before vegetation reclothes the burn. The thinner stand of less erosion-resistant plants, such as annual weeds, that often follows destructive fires for a number of years offers much less opportunity for absorption of precipitation and much less protection to the soil. Logging skid trails may also cause temporary and local damage which, however, can largely be overcome by placing in the roads and skid trails the brush from felled trees.

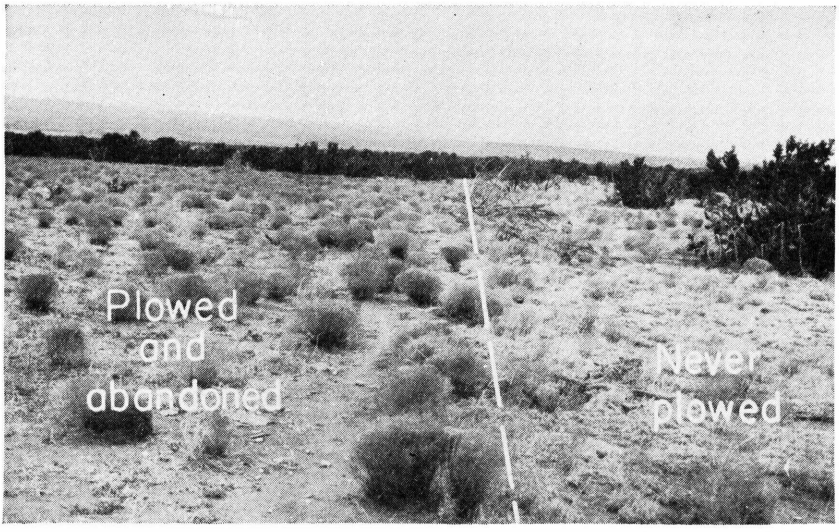

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FIGURE 31.—Plow indicators, not cow indicators. This old abandoned field, cultivated a number of years ago, no longer shows the furrows of the plow, but does show very thin sod (where the original grasses are so very slowly returning), and, as a disturbance indicator, a heavy stand of snakeweed, which occurs on the adjoining range also, but in smaller amounts.

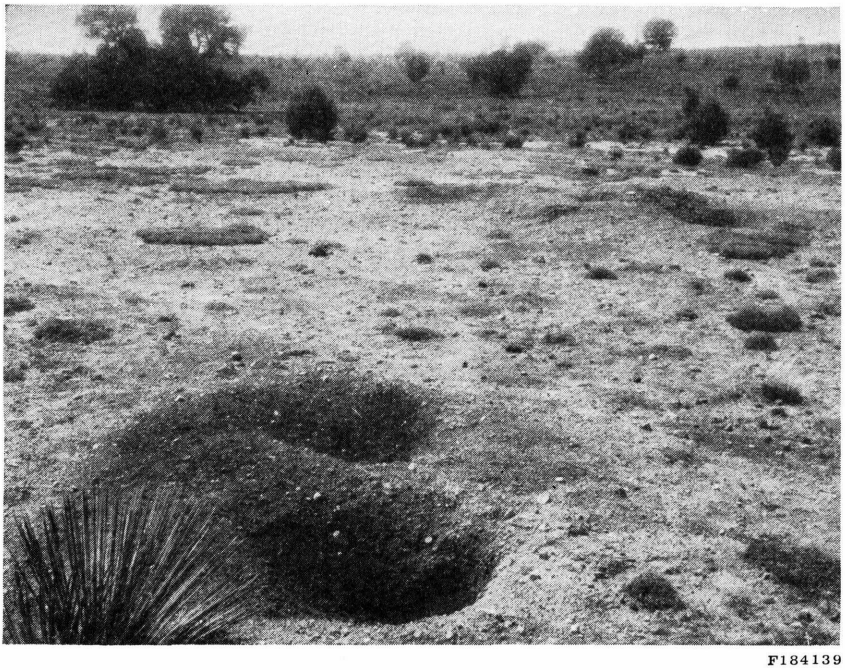

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FIGURE 32.—An old dog town. Prairie dogs consume the forage and kill the sod. Over many areas they are the most active factor in range destruction

IMPORTANT POINTS CONSIDERED BY EXPERIENCED RANGE JUDGES

Obvious, but nevertheless important, is the reminder that a range cannot be fairly judged unless a fair sample of it is seen. Topography, vegetation, and use can rarely be estimated from the principal travel routes. The aim should be to observe conditions distant from roads and trails as well as adjacent to them; farthest from watering places and also nearby.

In arriving at their conclusions experienced range examiners give particular weight to a few outstanding points.

HISTORY OF PAST AND PRESENT USE

More accuracy in sizing up any range always follows a close study of its history. What did the range look like 15, or 40, years ago; what changes have occurred in recent years (1) in kind, vigor, or abundance of plants, (2) in size of forage crop, (3) in timber growth, and (4) in extent and degree of soil erosion? In other words, is the present vegetation essentially stabilized or changing?

With reference to these points, the experience and remembrance of reliable old-timers should be consulted freely and their testimony considered along with other evidence. Much evidence concerning changes often may be obtained from burns; for example, charred juniper stumps can still be found on certain brush ranges which are not supporting a tree growth now. And, again, comparisons with ungrazed or well-managed areas are almost essential.

How does present stocking compare with past stocking? All available records, and other sources of information, should be consulted and analyzed in the attempt to determine fluctuations in numbers of livestock and actual periods of past grazing.

How does present handling compare with former handling? Puzzling questions relating to the looks of a range can often be explained when one learns of some radical change within the last few years, either in the kind of livestock or in their handling.

KIND OF RANGE

In considering the factors of topography, soil, and vegetation lands may conveniently be classified for broad inspection purposes, as follows: Short-grass ranges (fig. 1); meadows, locally called "cienagas" (figs. 28, 33); bunchgrass ranges (figs. 17, 29); brush (or browse) ranges (fig. 20); desert ranges (fig. 3); mixed types (figs. 2, 7).

Topography and Soil

A degree of use that may be satisfactory on level or undulating land usually becomes dangerous use in rolling country and destructive overgrazing on ranges of steep rough slopes (figs. 1, 2, 3).

A closeness of use that would be safe on heavy, compact, rock-studded soils, for example, will usually be destructive on loose, ashy soils. After soil washing once starts in deep clays or clay loams, gullies are apt to continue eating back long after the original causes of their beginning have been removed, unless soil stabilization can be hastened by check dams or other artificial erosion-control structures. In such deep soils the erosion damage is not so permanent and far-

reaching in effect as in thin veneers of soil overlying shallow bedrock; once such thin veneer is worn away the damage is complete and permanent.

The Vegetation Type—Its Make-Up and Forage Value

Forage plants differ in their ability to retain vigor and productivity under heavy grazing. For instance, sample plots on bunchgrass ranges in northern Arizona, periodically observed since 1912, bear witness definitely that, when ranges are continuously overgrazed, Arizona fescue and mountain muhly both disappear from the range before blue grama (*Bouteloua gracilis*), whereas black dropseed (*Sporobolus interruptus*) is the most resistant of all.

F21597A

FIGURE 33.—A meadow or cienaga. These localized areas of deep, damp soil produce a greater volume of forage than the adjoining drier slopes and ridges.

Secondary forage plants little relished by livestock sometimes are only slightly grazed when found intermingled in small percentages with good forage like bluestem wheatgrass (*Agropyron smithi*), blue grama, or curlymesquite. Proper utilization under these conditions should be judged by a closeness of use approximating 40 to 50 percent of the herbage of the more palatable species. Utilization of the less palatable plants should not ordinarily be a factor in determining proper use of the range, although heavy use of such plants may be a cue to further check on the utilization of the more palatable plants.

Summer and winter ranges are rarely balanced. Efforts to utilize all available range, therefore, have resulted in much damage, especially where the winter range has been inadequate. The relative sufficiency of summer and winter range and facilities for shifting livestock from one to the other should be carefully weighed.

Certain plants are greatly relished—much more so than the bulk of the forage. Where such plants occur very scatteringly over the range they may be severely grazed, and the condition of the unit as a whole should not be judged by their appearance. If these plants comprise only about 5 percent of the vegetation on ranges which do not otherwise show deterioration, they usually are sacrificed in order to obtain a satisfactory use of the remaining 95 percent of the vegetation, provided that overgrazing and gradual disappearance of the 5 percent does not result in soil washing. If the stand represented by this 5 percent is being eliminated, however, it will be necessary to readjust the stocking downward, to the extent of that forage, to prevent overgrazing of other important palatable plants. Also, on depleted ranges, the 5 percent may be the only remnant of a much higher vegetative type and should be encouraged to spread.

SEASON AND TIME OF EXAMINATION

Because of the extreme variation in southwestern climate from year to year and the corresponding rise and fall in forage production, it is essential for the examiner to know whether the current season is much better than average, much poorer than average, or just about average—in rainfall, forage production, and stock-watering conditions. To ignore this point is to invite decided error, because of the annual fluctuations in size of forage crops. Furthermore, the nutritive value of forage varies from season to season.

Another important point is that following drought, the first year of average rainfall may not produce an average forage crop. Weakened forage plants rarely recover in one season, and the stand is ordinarily below normal.

In any year the general appearance of southwestern ranges may vary greatly from month to month. The degree of variation depends upon the season, and upon the type of range, particularly its altitude. On the desert ranges in southern Arizona, for example, there is no similarity between the appearance in March and in July. In any examination, then, two vital points should be watched: (1) The development of vegetation to be expected at that time of year, and (2) the portion of the grazing season remaining at the time of examination. The first point entails a working knowledge of the stage of growth usually attained by the various kinds of forage plants on the date in question and also an approximate knowledge of the stages of growth to be expected during the remainder of the grazing season. In dealing with the second point, the percentage of the forage crop still ungrazed must be correlated with the portion of the grazing season still remaining. In arriving at this comparison of crop percentages, temporarily fenced exclosures, which permit the important forage plants to make full growth each year before being grazed, will be found of great assistance.

KEY AREAS

Weak spots often finally determine satisfactoriness of grazing use. Throughout the Southwest, choice mountain meadows on which animals congregate, areas of thin soil less able to withstand grazing, south exposures heavily grazed during the winter, and the drainage lines that form natural trailways of livestock between feed and water,

are danger areas. They must be carefully watched and, if necessary, the utilization of 75 percent or more of the unit reduced in order to prevent their breakdown.

A limited amount of this kind of damage is, of course, unpreventable if the area is grazed at all. Small areas around watering places, for example, cannot usually be protected from overgrazing. When these areas extend out one-fourth to one-half mile from water, however, conditions are decidedly unsatisfactory. As rough guides, these overgrazed areas of livestock concentration should always be kept below 5 percent, and in practically all cases below 3 percent, of the total area. But the significance of these damaged areas—not merely their acreage percent—is the more important "yardstick" to apply. On certain tracts of grazing land the damage is of little consequence, beyond its slight reduction in grazing capacity. In the heads of canyons and elsewhere, however, depletion of plant cover on a relatively small area may cause serious damage to lands far below the overgrazed spot as a result of accelerated runoff and erosion.

TIPS ON ESTIMATING GRAZING CAPACITY

Round Up Obtainable Forage Facts

A working knowledge of feed values of various combinations of forage plants to different classes of livestock, under practical management, is indispensable. Range judges must know the vegetation they are judging—the most important plants and classes of forage—their common names, growth requirements, and forage values.

Utilize Range Analysis Information

Range analysis estimates based upon a systematic field inventory of available forage are valuable guides. They provide an evaluation of the range and its current or past management. The analysis determines boundaries of the range suitable for grazing by livestock, condition and trend of the vegetation, soil stability, and forage utilization. Grazing capacity is estimated by applying animal-unit-month guides according to vegetation types and condition classes. These guides are developed from actual grazing-use records on demonstration and experimental ranges, and comparison of actual use with proper use as measured by the best available utilization standards over a period of several years.

Current vegetation condition and soil stability are rated by means of score cards. Vegetation condition is evaluated on the basis of density, composition, and vigor of range plants. Soil stability is rated by the amount of bare soil and current rate of soil erosion.

Trend in range condition is measured by the 3-Step Method. This method, in use on national-forest range areas, provides permanently established benchmarks for measuring changes in range forage and soil cover through the years. In brief, the 3 steps are: (1) A record of measurements and observations of vegetation and soil stability;

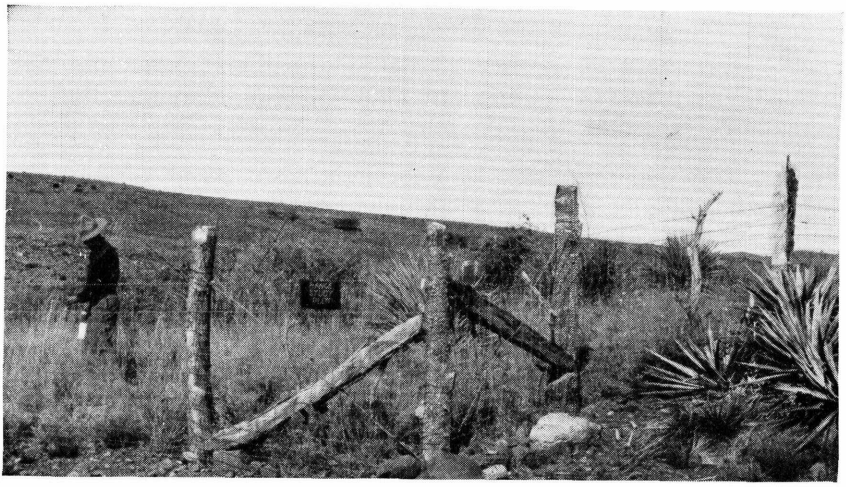

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FIGURE 34.—A range study plot. Fenced areas of this kind are employed for the scientific study of any vegetation changes which may be going on, especially the very slow ones that are difficult to follow from year to year by observation alone. Areas fenced against grazing also provide practical aids in judging current utilization.

F39857A

FIGURE 35.—A quadrat or small sample plot. In range studies various kinds of plots are employed. One kind is here illustrated. Small squares on the ground are marked by stakes, and plant maps are made at intervals in order to provide an accurate and permanent record of any vegetation changes.

(2) interpretation of this record in terms of condition classes (excellent, good, fair, poor, and very poor); and (3) initial and repeat photographs from permanently located points, used in later judgings of trend. A fuller explanation of the 3-Step Method is given in: Forest Service, U. S. Department of Agriculture, "A Method for Measuring Trend in Range Condition on National Forest Ranges." June 15, 1954. (Processed.) A copy may be found in agricultural libraries or obtained by writing to the Forest Service, U. S. Department of Agriculture, Washington 25, D. C.

Study the Contrast Revealed by Areas Protected From Overgrazing

Fenced ungrazed plots (fig. 34) with their supplementary sample plots (fig. 35) are widely used in range studies. In addition they

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FIGURE 36.—Ungrazed or well-managed areas offer comparisons valuable to the range manager. This railroad right-of-way, for example, is a guide to the kind and amount of forage that the adjoining range is capable of producing.

provide practical aids to the judging of range utilization. They show, for example, what the grazed range would look like if ungrazed. The important forage plants are more easily recognized and, on plots fenced for protection from grazing during the growing period, the ungrazed sample gives an idea of the size of the current year's forage crop and adequacy of range feed for the remainder of the grazing period. If the plots have been closed to grazing for several years, or longer, they also reveal the cumulative effect of past grazing use on the adjacent range but are more difficult to use in judging current degree of utilization.

Other available ungrazed or well-managed areas should be utilized as far as possible to supplement specially fenced plots. Such substitute areas may be: Railroad rights-of-way (fig. 36), cemeteries, inaccessible bits of range, ungrazed corners of cultivated fields, and pastures or allotments in which grazing is deferred or otherwise well managed.

Give Special Consideration to Overgrazed Areas

In making estimates of grazing capacity for overgrazed ranges, remember that they are overgrazed. Avoid the mistake of judging grazing by the results of overgrazing. In attempting to better conditions on run-down lands, all probable causes should be weighed. First, a reduction in numbers of animals usually will be necessary. Next, distribution of livestock can often be bettered through improved handling (water development, salting, riding, fencing). Occasionally a change in kind of livestock is advisable. On other areas, all that may be needed is a shorter grazing period, or deferred and rotation grazing—the resting of portions of the range in turn until after seed has ripened. In extreme cases of excessive damage where all other remedies have failed, exclusion of grazing animals may be required.

Adjust Estimates to the Date of Examination

If a yearlong range is examined early in October and the next year's growth is not expected before July, more than three-fourths (roughly) of the current year's forage should remain uneaten at the time of examination. In contrast, on a high-altitude summer range also examined in October, 40 to 80 percent of the edible herbage may be gone and the range still be judged in satisfactory condition (as far as percentage of the crop already grazed is concerned). The correct judging of the portion of the current year's crop already grazed, or still remaining, requires careful observation and drawing upon all available experience and knowledge regarding the feed values of the important plants, and the dates of beginning and ending of growth and of grazing.

Make Deductions for Unfavorable Factors

Do not base estimates of grazing capacity on the total crop of edible forage. Deductions (in an amount varying with each individual case) are almost always necessary to allow for one or more of the following adverse conditions: (1) Rough or inaccessible areas which cannot be fully utilized; (2) inadequate watering facilities—either insufficient amount or unsatisfactory distribution over the range; (3) abundance of poisonous plants which necessitate light grazing; (4) dense timber; (5) young timber growth; (6) poor distribution of stock; (7) heavy populations of game animals.

Check Initial Estimates by Follow-Up Field Examinations

Watch carefully the effect of first attempts at proper stocking, applying, particularly at the end of the grazing period, all practicable tests of satisfactory use.

Keep in Mind the Value of Permanent Forage Records

In order that the changes through the years may be followed more closely and with less chance of serious error, because of the frailty of memory, more systematic recording of observations is urged. Ten

years from now even a brief word-picture of conditions today on any tract of grazing land will be of great service to range managers and owners in bringing about satisfactory range management.

Remember the Basis of Permanent Sustained Grazing Capacity

Good range management is, after all, the end sought by range judging. Good management consists chiefly of three simple elements: (1) Proper period of grazing use by the kind of livestock to which the area is best adapted; (2) satisfactory distribution of livestock over the area; and (3) proper numbers of animals.

Stocking southwestern ranges on the basis of the worst drought years is uneconomic and impracticable. Stocking on the basis of the best years is a suicidal policy. To maintain the resource, ranges should be stocked on the basis of 65 percent of average forage production. When the dry years come, numbers of livestock should be reduced by close culling, or—if practicable—supplemental feed should be provided or the grazing period shortened. Since there apparently is no such thing as a normal year in the Southwest, the use of this term is discouraged.

Any estimate of grazing capacity should be aimed at the attainment of the happy medium between abuse and nonuse. It means eliminating, to a point consistent with practical management, both overgrazing and excessive waste of forage. It does not mean the largest number of animals that can be carried through without heavy loss. It does not mean that the end of each grazing season should find the previous season's growth of forage entirely consumed, because uncertainties of southwestern climate and practical difficulties in handling livestock do not permit of a nicety of adjustment sufficient to place precisely the correct number of animals on an area each season to use all the forage without overgrazing the area. *Some forage should remain on the ground at the end of the grazing period.* This should be considered insurance rather than waste.

The aim should constantly be to so adjust grazing as to keep the ranges as nearly as possible in a permanent state of maximum forage production and to afford adequate protection to watersheds and other public values. In cases of doubt, especially concerning possible injury to watersheds, the only safe basis to work from is not what the forage will carry but rather what the soil will carry.

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